Remarks

Claims 1-35 are pending in the application. Applicants thank the Examiner for acknowledging the allowance of claims 25-30 and 32-35 and the allowability of claims 4-5, 7-8, 16-17, 19-20 and 31.

Objection to claim 31 under 37 CFR §1.75(c)

Claim 31 was objected to as being of improper dependent form for failing to further limit the subject matter of claim 25 from which it depends. Claim has now been canceled, obviating this ground for objection.

Rejections of claims 1-3, 6, 9-15, 18, and 21-24 under 35 U.S.C. 103(a)

Claims 1-3, 6, 9-15, 18, and 21-24 were rejected under 35 U.S.C. 103(a) as being unpatentable over Bakker[1] in view of Haberland[2]. Applicants respectfully traverse these rejections.

(A.) Claim 1, as previously amended, recites (with emphasis added in bold):

An apparatus for gas cluster ion beam (GCIB) processing including mass or cluster size diagnostics for improving GCIB workpiece processing, comprising:

a vacuum vessel;

a gas cluster ion beam source within the vacuum vessel for producing a gas cluster ion beam;

an accelerator for accelerating the gas cluster ion beam ***along a trajectory;***

a beam gate for controllably interrupting and restoring the gas cluster ion beam;

beam current measurement means disposed along the trajectory at a predetermined distance, L, from said beam gate;

workpiece holding means disposed along the trajectory for holding a workpiece for gas cluster ion beam processing;

[1] U.S. Patent No. 3,634,683 issued January 11, 1972, to Bakker, Johannes M.B.

[2] U.S. Patent No. 5,110,435 issued May 5, 1992 to Helmut Haberland

control means for providing beam gating signals to said beam gate that controllably interrupt and restore the gas cluster ion beam;

time-of-flight measurement means for measuring the times-of-flight of components of the gas cluster ion beam over said distance, L; and

a time-of-flight analyzer to analyze said times of flight of components of the gas cluster ion beam in order to provide output information relative to GCIB mass or cluster size;

wherein said output information is used in the gas cluster ion beam processing of the workpiece.

The Action asserts that Bakker's element **s1** in **Figure 2**[3] discloses a beam gate that controllably interrupts and restores the ion beam. Applicants reiterate the argument made in Applicants' previous response (of 26 September 2003) regarding element **s1** that it does not appear has been addressed in the instant Action. Element **s1** consists of a biased electrode between the two pairs of Y **21** scan plates and X **22** scan plates and is described by Bakker as "a geometry control electrode".[4] Element **s1**'s function is to focus the ion beam and/or shape the electric fields of the two sets of scan plate pairs so that they do not interact. The biasing of **s1** at 180V is provided by a voltage divider across a fixed voltage power supply and thus does not vary controllably in such way as it could constitute a beam gate for interrupting the beam as recited in claim 1. Additionally, nowhere in Bakker is there a teaching or even suggestion of employing a "beam gate for interrupting and restoring the beam". Bakker's ion beam is continuous, as described in several places in the Bakker reference[5]. The presently claimed invention recites a beam that is completely interrupted and restored by the beam gate, not deflected from one trajectory in the vicinity of a target (i.e., collector slit **4** and collector **5**) to another in continuous operation as in Bakker. Bakker's pair of scan plates (as shown in

[3] Please note, element S1 does not appear in Fig. 2, but rather in Fig. 1.

[4] Bakker, col. 3, line 6

[5] Col. 1, ll. 45-46; Col. 2, lines 28-30; *and* Claim 1, "...means for substantially continuously generating a beam of ions and accelerating such beam in the direction of a target...".

Fig. 2) deflect the beam stepwise from one trajectory to another[6], but the beam is never interrupted nor restored.

Nor do Bakker's scan plates function as a "beam gate" - they operate to deflect the beam from one trajectory to another[7], forming a beam "kink" in the process. Bakker's ion beam remains continuous and is never interrupted or restored, rather it is deflected from one position in the vicinity of a central slit target to another position on the opposite side of the slit target, briefly sweeping across the collector slit **4** and collector **5** by means of scan plate deflection.

It may also be the case that the Examiner is reading limiting language into claim 1 that is not present in claim 1. Claim 1, unlike claim 12, is directed to interrupting the gas cluster ion beam from propagating in any direction.

The teachings of the Haberland reference do not supply the "beam gate" subject matter missing from Bakker. Also, Haberland is cited for teaching an apparatus for gas cluster ion beam processing with a suggestion in the Abstract (but an inadequate disclosure) of using a time-of-flight mass spectrometer to investigate the cluster size distribution. Haberland, however, does not actually teach a gas cluster ion beam - a gas cluster ion beam is formed from a precursor (source) material that is a gas under normal conditions of temperature and pressure. Haberland rather teaches forming an ion beam from vaporized solid source materials.

In light of the foregoing, as neither Bakker nor Haberland either alone or in combination teach or suggest the presently claimed invention as recited in amended claim 1, Applicants respectfully submit claim 1 is patentable over the cited art. Additionally, each of the rejected dependent claims 2-3, 6, and 9-11, as well as independent claim 23 contain the "beam gate" and "interrupting and restoring" limitations that are present in claim 1. Applicants, thus, respectfully submit that rejected claims 2-3, 6, 9-11 and 23 and objected to claims 4-5 and 7-8 are similarly patentable over the cited art.

(B.) Rejected independent claims 12 and 24 each include the following limitations (with emphasis added by bolding):

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[6] Bakker, col. 1, ll. 57-68

[7] Bakker, col. 1, ll. 20-22

a vacuum vessel;

a gas cluster ion beam source within the vacuum vessel for producing a gas cluster ion beam;

an accelerator for accelerating said gas cluster ion beam along a first trajectory;

a beam deflector for controllably interrupting and restoring the gas cluster ion beam flow along the first trajectory by deflecting the gas cluster ion beam along a second trajectory;

beam current measurement means disposed along the first trajectory at a predetermined distance, L, from said beam deflector;

control means for providing beam deflecting signals to said beam deflector that controllably interrupt and restore the gas cluster ion beam;

time-of-flight measurement means for measuring the times-of-flight of components of the gas cluster ion beam along said distance, L; and

a time-of-flight analyzer to analyze said times of flight of components of the gas cluster ion beam in order to provide output information relative to GCIB mass or cluster size;

Neither Bakker nor Haberland alone or in combination teach or suggest "*...a beam deflector for controllably interrupting and restoring the gas cluster ion beam flow along the first trajectory by deflecting the gas cluster ion beam along a second trajectory...*" where said first trajectory terminates upon a "*beam current measurement means.*" Nor does either reference teach using output information from the time-of-flight analyzer in controlling the workpiece processing (*i.e.*, claim 12.) Haberland makes reference to an experimental time-of-flight analyzer in its Abstract, but nowhere teaches using the output in such a manner.

The presently claimed invention, as recited in claims 12 and 24, employs a deflector to controllably switch the beam between two trajectories - either along the first trajectory terminating in the beam current measuring means, or out of the beam current measuring means

along the second trajectory (and thus interrupting the beam along the first trajectory.) In contrast, Bakker has a deflector that, using step function excitation[8], switches his beam between two trajectories[9], neither of which *terminate* in a beam current measuring device. Rather, during the beam switching transient, the beam sweeps *across* collector slit 4 and/or collector 5 and the short resulting current transient is measured and analyzed. There is a resulting "periodic effect on the collector"[10] from the beam transiting the current collector.

In light of the foregoing, Applicants respectfully assert that claims 12 and 24, as amended, as well as those rejected claims (13-15, 18, 21-22) and objected to claims (16-17, 19-20) that depend from claim 12, are thus similarly patentable over the combination of Bakker and Haberland.

The foregoing arguments made with respect to claim 12, as amended, related to the cited art's failure to teach or suggest workpiece processing, GCIB and GCIB sources, and controlled deflection between two trajectories, one of which terminates upon a beam current measurement means are relevant to the patentability of claim 24, as amended. Applicants, thus, respectfully assert that claim 24, as amended, is patentable over the combination of Bakker and Haberland.

For at least the above noted reasons, Applicants respectfully submit that claims 1-30 and 32-35 are in a condition for allowance, and respectfully requests that the Examiner reconsider and withdraw all outstanding rejections and objections. Favorable consideration and allowance are earnestly solicited. Should there be any questions after reviewing this paper, please call Applicants' attorney at 617-854-4000.

Respectfully submitted,
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[8] Bakker, col. 1, ll. 20-22

[9] Indicated respectively as a0,a1,a2,a'0,a'1,a'2 and e0,e1,e2,e'0,e'1,e'2 in his Fig. 2 and described in Col 3, lines 45-56

[10] Bakker, col. 1, ll. 45-50

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